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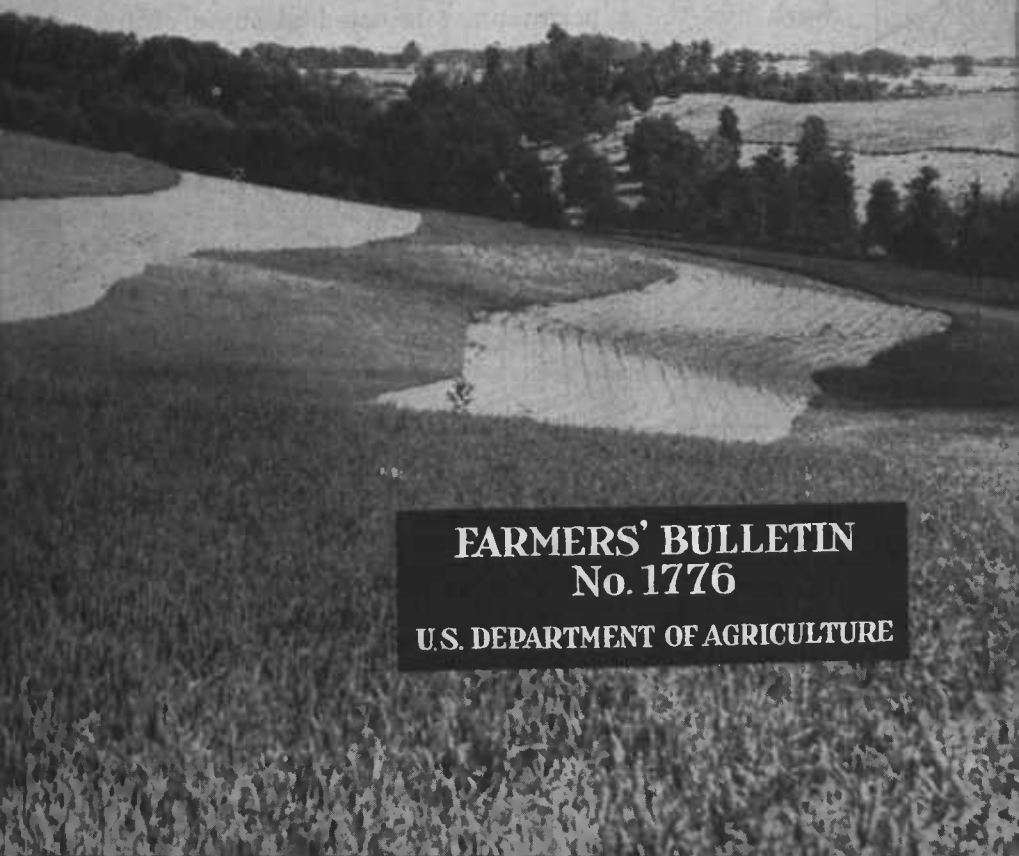
Strip Cropping

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STRIP CROPPING FOR SOIL CONSERVATION

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INTRODUCTION

TO FARM SUCCESSFULLY and continuously on steep hill-sides has always been a major problem to the farmer. The difficulty of holding the land has been easily recognized because on these steep slopes erosion progresses at a rapid rate and is visible from year to year. While the same destructive movement of soils has been taking place on the more gentle slopes, it is not as spectacular and usually has been overlooked until most of the productive topsoil was gone from the fields and the plows began turning up the infertile subsoil.

In contrast to the elaborate systems of terracing constructed by ancient peoples, farmers and agricultural leaders in California, eastern Ohio, western Pennsylvania, Kentucky, Wisconsin, Minnesota, and other places in the United States have developed a system of successfully farming their steep slopes that has the good points and omits many of the bad features of the ancient methods of hill-side farming.

Steep slopes, ranging from 10 to 50 percent in grade, have been utilized for crop production since long before the white race first practiced systematic cultivation of the land. The Chinese and Japanese have long grown rice upon the stairstep hillsides that sweep upward from the rivers.

The ancient Incas of Peru (probably one of the most highly advanced agricultural people the world has known) carried on their

farming with a fervor that bordered on fanaticism and built one of the most elaborate and lasting systems of terraces which history records. So successful and so foresighted were these inspired builders of land that even today, after 4,000 years of continuous cropping, the same plots are supporting their descendants. Such effective methods of land usage were not without their cost. Walls of perfectly joined masonry, 6 to 12 feet in thickness and 8 to 20 feet in height, were constructed by manpower alone, in order to retain an area seldom larger than an acre. It is said that good rich earth was packed 700 miles on the backs of llamas to carpet those precious mountainside plots which were often so narrow that only two rows of crops could be planted throughout their entire width.

Later, the Germans, in the fertile valley of the Rhine, terraced the banks of slopes so steep that the retaining walls of the plots often had more area than was made available for the growing of their grapes.

Such methods of adapting the hillsides to production invariably called for an expenditure of labor that would be prohibitive for the modern American farmer. But the need of protection on the steeper slopes, in fact, on all sloping land, is just as essential if such lands are to be successfully cropped through the centuries. Fortunately much of the good agricultural land in the United States is sufficiently level possibly never to require the extreme measures taken by the ancients, if careful attention is given to maintaining fertility and to preventing the loss of the soil itself by wind or water. Holding the soil in place and maintaining its spongelike absorptive qualities requires utilization of the land for that type of vegetation to which it is best adapted and the use of other good farm practices known to conserve soil. The American farmer is not alone in his keen interest in this problem of holding the soil. Italy, South Africa, Australia, and many other countries are making liberal use of their financial and intellectual resources in attempting to check erosion and conserve their soils.

Strip cropping has been successfully employed in some localities for many years as one of the practical measures to conserve soils. More recently it has attracted widespread interest as a result of the experimental work and field demonstrations conducted by the Soil Conservation Service. It has been used to protect large fields with long slopes which in the past have been plowed and cultivated as a unit and thereby exposed over their entire area to severe erosion by wind or water. The greatest loss occurs during periods of clean cultivation when the ground is bare of vegetation. Frequently, under such conditions, especially in the humid regions, apparently harmless run-off from the tops of the slopes accumulates momentum, volume, and soil load (fig. 1), until it becomes destructive as it approaches the foot of the slope. Severe soil losses also occur in arid regions subject to wind erosion (fig. 2) when there is nothing to check the velocity of the wind or filter out its abrasive load of sand and silt. A strip-cropping system, on the other hand, breaks up the length of these slopes, prevents this accumulation and its resultant destructiveness of soil and plant food, and provides protection for the area at all times.



FIGURE 1.—Long sloping rows encourage the movement of thousands of tons of "pay dirt", which are forever lost to the farmer and clog drainage ditches and fill canals, lakes, and reservoirs.



FIGURE 2.—Results of wind erosion. Fences are nearly buried by rich soil blown from fields. Strips of wind-resistant crops distributed over this field would have prevented this loss.

THREE TYPES OF STRIP CROPPING

The three types of strip cropping commonly used in parts of the United States to meet various conditions are here defined.

Contour strip cropping (fig. 3) is the production of the ordinary farm crops in long, relatively narrow strips of variable width on which dense erosion-control crops alternate with clean-tilled or erosion-permitting crops placed crosswise of the line of slope approximately on the contour. It is usually impossible to have parallel strips with all the rows of a given strip exactly on the level or true contour because of variations in the slope of the land. While it is



FIGURE 3.—Contour strip cropping on a steep hillside in West Virginia. Note how these strips follow the contour of the slope protected by erosion-resisting vegetation between the cultivated row-crop strips.

desirable to follow the true contour, it is sometimes permissible to deviate to some extent in order to make the cultivated rows of uniform length and to avoid point rows. It has been found in practice that if the soil is fairly permeable and the deviation is slight and continues for only a hundred feet or less, this deviation will cause no serious results.

Field strip cropping (fig. 4) is the production of the regular farm crops in more or less uniform parallel strips laid out crosswise of the general slope but not parallel to the true contour. This is a modified form of contour strip cropping and is applicable to uniform gradual slopes on soils which are resistant to erosion. Field strip cropping is very simple and while not as effective as contour strip cropping, can frequently be used in connection with grassed waterways where the true contour cannot easily be followed.

Wind strip cropping (fig. 5) is the production of the regular farm crops in long, relatively narrow, straight, parallel strips placed crosswise of the direction of the prevailing wind without regard to



FIGURE 4.—Field strip cropping enables this Pennsylvania farmer to control erosion effectively and maintain profitable crop yields on relatively steep slopes. This method is more applicable to uniform slopes, but since these strips are not always on the contour, water will sometimes concentrate in the lower areas. These must be protected by leaving them permanently in sod.



FIGURE 5.—Corn and sorghum in strips help to prevent run-off and are effective against wind erosion on the high plains of Texas. On slopes less regular, contour strips are more effective for water conservation, which in turn increases the vegetative cover, giving more protection against wind erosion.

the contour of the land. Wind strip cropping is an effective agent in preventing wind erosion but may be of little value in conserving water.

CONSERVATION MEASURES

Before consideration is given to the subject of strip cropping some understanding of the principal methods of soil and water conservation now in effect is essential to a grasp of the subject.

Broadly speaking, the practical methods of soil-conservation technique are divided into two important classes: Mechanical and vegetative. Each of these broad classes of conservation technique



FIGURE 6.—Benchlike terraces formed by nature. The abrupt slopes between the benches are protected by a vegetative cover which forms a type of buffer strip. Nature suggests contour strips for protection against erosion.

supplements and strengthens the other at most points in the soil-conservation program. A brief description of the principal methods in each class also further emphasizes the importance of strip cropping, particularly in connection with other related methods of soil and water conservation.

MECHANICAL STRUCTURES

In the fight against soil and water wastage, many types of mechanical structures are being employed. Nature has pointed the way to conserve soil and water with terracelike formations (fig. 6), combined with vegetation. Many of these control measures may be applied in all sections of the country, while others are more or less restricted in their use to particular areas or farming conditions. In many sections terraces are used (fig. 7), especially in cultivated fields, to retard water run-off and to allow the soil more opportunity to absorb additional moisture, thereby making it avail-

able to the growing crops. Diversion terraces, sometimes called "interception ditches", prove very effective in safely intercepting and diverting excess water and discharging it into controlled waterways, where no damage will result. Dams of various types are constructed to protect gullies, check water in draws, prevent further cutting, and form ponds or reservoirs for the conservation of water for use by plants and livestock.

Various types of structures are in use for the protection of stream banks and overflow lands. Many streams are very destructive to their banks during certain periods of the year, especially during the spring freshets caused by rains, ice, and melting snow. In many northern streams and rivers heavy log and stone structures are built



FIGURE 7.—These terraces furnish ideal guides for contour strip cropping. Terraces represent considerable investment and should always be protected by strip cropping. These terraces were built by the Soil Conservation Service.

to break up the ice flow during the spring thaws. Stream-bank structures are built to deflect the current and prevent cutting along the edges and in many cases to prevent changing of the stream channel itself.

VEGETATIVE CONTROLS

No better measures to control erosion have been devised by man than those found under natural conditions. Woods offer one of the best controls when they are protected from grazing by livestock and from fire. In heavily wooded sections a thick mat or layer of leafmold is found on the ground. This serves the same purpose as a blotter in absorbing a blot of ink on a piece of paper. Forest soils are frequently high in organic matter or humus, which increases tremendously their absorptive power and allows very little of the water to move from the point where it falls as rain. The leaves and branches break the force of the falling raindrops and cause them to drop gently upon the layer of leafmold, thus greatly

reducing their erosive power. By their shading effect and by their protection against warm, melting winds, woods offer protection in the spring against the too rapid melting snow.

Grass is another of nature's methods of controlling soil and water losses and one of man's best allies against erosion. Lands covered by a natural, heavy sod of grass suffer no serious run-off or loss of valuable topsoils in seasons of normal rainfall. On lands too steep to cultivate without great soil loss, grass gives adequate protection. Cultivated fields can be protected during a part of the year by cover crops composed of grasses and legumes, which break the force of the rainfall and make possible a greater absorption of moisture.

CONTOUR STRIP CROPPING

Contour farming is level farming on sloping land. Technically, a contour line is the line made by the intersection of a horizontal plane with a sloping surface. Practically, it is a line drawn so that any deviation from that line is a departure from the level. Contour farming is, therefore, farming on the level instead of up and down the hill. It is a practice which interrupts the flow of water down a slope and causes the water to remain within the soil or to travel slowly along a gentle slope. The vertical distance between the plane of one contour and that of the next is called the "contour interval."

There are a number of reasons for laying out fields on or nearly on the contour of the slope. Water poured upon a plain sloping surface in a thin sheet would flow with equal depth down that plane without any tendency to accumulate in streams. If, however, the water could be interrupted in its flow by a low ridge erected across the plane on a contour line, it would accumulate above the ridge, without any tendency to flow along the upper side of the obstruction. If the ground surface in any particular strip were corrugated by a number of such level ridges in lines parallel to the long boundaries of the strip, each corrugation would serve as an added check to the downward flow of water. This is essentially what happens when the rows of the cultivated crops are planted on the contour instead of up and down the slope.

In the cultivation of land the plow furrows carried around a slope, approximately on the level, act as a series of small earthen check dams to obstruct the free flow of water down a slope; harrow grooves serve as intermediate corrugations to assist in the retardation of the flow; the rows of cultivated crops and the small furrows made by the cultivator succeed the harrow grooves to serve as checks during the growing season; the lower border of the strip becomes slightly ridged to serve as a final obstruction to the flow of the water to the next lower strip. It is of course necessary in farm practice to allow some slight deviation of the strip from the absolute horizontal in order to keep it uniform in width and to facilitate adequate drainage.

If crop strips could be laid out exactly on the contour, there would be little tendency for the concentration of run-off water from rainfall, because the top and bottom boundaries of a given strip would be level. Any run-off flowing from one strip down upon another would be in a thin sheet of approximately uniform depth. By these strips or checks it is possible to prevent gullying, which is produced

by the rapid flow of a concentrated stream of water, carrying debris down some channel into which several sloping surfaces lead.

Because of the original rectangular lay-out of lands, both the public lands acquired from Federal or State Governments and those originally purchased from the different private land companies, there has been forced upon the farmers a system of field arrangement which is ill-adapted to the requirements of a rolling or hilly topography. It has been said that the land system "tried to fit square farming to a round country." Frequently the farm lies in a long, narrow strip, stretching from some small valley up a hill slope to a more level plateau above. Such an arrangement promotes rapid run-off from the accumulating area above, down the slope to the more level land below.

Moreover, such farms frequently are subdivided lengthwise into several fields, and the areas along division fences are grown up to trees and brush or have become ridges rising above the levels of the fields through long-continued plowing of headlands away from the dividing fence. The removal of such fences and brush rows may be very desirable in order to secure a longer, if narrower, lay-out of the cropped fields around the slope. Transverse fence lines which are on the contour frequently can be included in the strip system and made to form very desirable established obstructions to the downward rush of surface water.

In the past, American farmers in general have taken pride in rectangular fields with their straight rows. This attitude is based on both tradition and teaching, and is naturally hard to change. On most farms strip cropping can be so arranged as not to increase the total haul from the fields to the barns or storage houses. Usually it is possible to lay out a strip-cropping system so the rows will actually be longer than under the square-field system. It should be kept in mind that it is possible to have approximately the same area of tilled crops, small grains, hay, and grass under the strip-cropping system as under the old square-field system. Only the arrangement of these crops in the fields is changed.

ADVANTAGES OF STRIP CROPPING

Strip cropping, combined with contour tillage and terracing where necessary, has been proved by experiment stations of the Soil Conservation Service and by cooperators in the various demonstration areas to be very economical and effective, and the most practical means of controlling erosion and conserving soil and water on cultivated land.

It is now known that, other factors being equal, the longer the slope the greater the degree of erosion. Contour strip cropping (fig. 8) divides the length of the slope, checks the momentum of run-off water, filters out the soil being carried off, and increases the absorption of rain water by the soil.

The multitude of obstructions offered by the dense, close-growing crops in the alternate strips slow down the rapid flow of water, thus permitting it to soak into the soil and, by spreading the water, prevent it from concentrating in low areas and gullies. They also deflect wind currents and prevent soil blowing.

Root growth opens pores in the soil and thus permits greater and more rapid absorption of rainfall. Dense vegetative growth on the control strips helps to keep these pores open by intercepting and dispersing the raindrops before they reach the ground, thus preventing the run-off water from becoming muddy, an important factor in increasing infiltration and preventing run-off. The muddy run-off water from the clean-tilled strips is slowed down, spread out, and clarified by the filter action of the close-growing crops. It can then be absorbed by the soil, and this results in a saving of water and greater production of vegetation.



FIGURE 8.—Effective erosion control by contour strip cropping in Ohio. The level cultivation of the row-crop strips not only materially reduces erosion but eliminates point rows, allows for longer rows, reduces power costs, and allows the corn shocks to be set up on the grass strips on either side so the entire corn strip can be sown to wheat.

The filter action is very important, as muddy water laden with sand and soil particles (fig. 9) is more erosive than clear water because of its higher specific gravity and because the sand particles themselves bump into and tear away other fine soil particles which fill the soil pores and thereby seal them against water penetration. As the soil load increases the erosive action increases at an accelerated rate. This results in tiny or great torrents, depending on the length of the slope, pushing, rolling, and gnawing away at the soil until gullies are formed.

Strip cropping has many other advantages. The control strip can be used to fill in irregularities of slope and take up point rows. These strips can be utilized to produce feed or small-grain cash crops, and in parts of the South the same strip can be made to produce two feed crops a year. Strip cropping encourages the use of a proper rotation and helps maintain a balanced production of food, feed, and cash crops.

Strip cropping can be installed at practically no cost, and the maintenance is very low as compared with the cost of maintaining

terraces and other mechanical structures. There are no outlets to maintain except the grassed waterways and the turn strips that are sometimes used with field strip cropping, and these should be utilized for feed production. The strips do not require the same degree of engineering exactness and accuracy in their installation as terraces. They can easily be moved or corrected if found inadequate or improperly placed. Strips offer no interference with use of machinery such as terraced land sometimes does.

Contour strip cropping, used in conjunction with terraces, reduces ridge wash and channel scouring and helps to prevent sand



FIGURE 9.—Straight rows up and down the hill in large fields speed up the transportation of fertile topsoil to the sea. On slopes of this character, contour tillage and strip cropping, if employed before erosion progresses too far, will keep all of the soil in the field.

bars from forming in channels. Strips that properly straddle the terrace ridges reduce the erodible slope length of the terrace interval and thus provide a better margin of safety for all installations designed to divert, retard, or prevent run-off.

During seasons of deficient rainfall run-off water from the clean-tilled areas that has been trapped and held by the control strips may be sufficient to make the difference between crop failure and success. Extra moisture is almost always needed at harvest time when grass or legumes follow small grain. Many good clover stands are lost for lack of moisture during this critical period following the harvest of the companion crop. The same conditions affect fall seeding following summer crops.

In the Northwest, where wheat production predominates, large-type machinery is used to harvest the grain, and fields are frequently opened up by being split into several strips. This results in a waste of grain, whereas if the grain had been grown in contour strips divided by strips of grass, for example, the strips would have been easily accessible and ready for the large harvesters without this

waste caused by back swathing. Contour strips are as easily and economically harvested as large square fields.

Increasing numbers of farmers appreciate the value of a vegetative cover on their land during the fall, winter, and spring months, when the soil is most susceptible to erosion. They prefer to leave the crop residue on the land to prevent run-off and to enrich the soil rather than to pasture it with livestock, which frequently do great damage to cultivated land by trampling the wet soil. Crop residue is often worth more for soil improvement by increasing the organic matter and humus, which is vital to good yields, than for pasture. At times when additional feed is absolutely essential, strips can be fenced in for pasture by using the new electric fence which is in use on a number of demonstrational areas. This fence consists of a single strand of barbed or smooth wire charged with an intermittent electric current generated by the ordinary storage battery of an automobile or farm lighting system. It is supported by insulators attached to small posts or stakes which can easily be erected or moved.

While strip cropping alone will not completely control erosion on all soils and slopes, it has so many advantages over the old system of plowing, cultivating, and otherwise subjecting the entire areas of large fields to erosion and consequent loss of soil and water that it merits careful consideration and adoption by practically all crop farmers.

SOME ECONOMIES OF STRIP CROPPING

REDUCTION OF SOIL LOSS

Contour cultivation is a great improvement over the old square-field system where the rows were run up and down the slope. The effectiveness of contour cultivation in controlling erosion is greatly increased, however, when used in conjunction with strip cropping. For example, at Temple, Tex., it was found that land with cotton planted on the contour lost 126 tons of soil an acre from July 30, 1935, to January 1, 1936, while under the same soil and rainfall conditions, land with cotton grown in a strip-cropping system, with winter oats as the filter strip, lost only 13 tons an acre. During the entire period of operations and demonstrations at Temple the Soil Conservation Service found strip cropping to be approximately 10 times as effective in controlling erosion as contour cultivation alone.

Under average field conditions there is usually a direct relation between the length of slope and the amount of soil loss by erosion. The Tyler (Tex.) Station in 1935 found that on land of uniform slope in continuous cotton the soil losses were as follows: In round numbers, 26 tons of soil an acre on a 36-foot slope; 36 tons on a 72-foot slope, and 57 tons on a 145-foot slope.

INCREASE IN YIELDS AND FARM INCOME

In the Soil Conservation Service project at Dalhart, Tex., water conservation is the most important factor in crop production. Here it was shown that strip cropping was an important factor in controlling and conserving water which had formerly run off as waste.

One farmer of Bellaire, Ohio, has this to say regarding the value of strip cropping:

We have been strip farming for about 25 years. Under this system we have been able to control the erosion and build up the fertility of our soil and maintain it so that we can produce about 50 percent more per acre than we could under the old system in 1908. One strip that we had in oats in 1935 made 64 bushels per acre, and the same ground in 1908 made 25 bushels per acre. We would not think of going back to the old way of plowing a whole field.

Near Woodsfield, Ohio, strip cropping has been practiced for a number of years. The people who originally settled there brought with them from European countries all the good points in cultural methods they had used in their homeland. These people settled principally in one township, which happened to be the roughest part of the county. Strip-crop farming was thus forced upon them by physical necessity. At the present time this township is the wealthiest in the county, has no State aid for schools, has practically every road surfaced, and has the lowest tax rate in the county. Strip cropping has helped to make these farmers prosperous for it has kept the soils on these mountainous slopes and has thus contributed to a permanent system of crop production.

In northwestern West Virginia and southwestern Pennsylvania the value of strip cropping has been demonstrated. Many farmers of that section have practiced it for 20 to 35 years. One farmer who started strip cropping in 1903 has been able since then to double and in a few cases triple his former yield. The most convincing evidence of the value of strip cropping is that those who have farmed by this method for many years are well satisfied and are making satisfactory crop yields. They are conserving the soil for future generations and aiding very materially in protecting the people on valley farms and in cities from floodwaters coming off the sloping hill country.

SAVINGS FOR HIGHWAY DEPARTMENTS

Highway departments spend thousands of dollars every year cleaning away the debris and soil washed onto the roads from adjoining fields. The washing of fertile soil from fields onto the highways is a direct loss of the producing power and capital of the farmer and its removal is a public expense that should be avoided. From a field of 15 acres in western Pennsylvania it was estimated by one of the highway foremen that approximately 60 tons of soil were removed by one rain. Most of this soil came from a cultivated field in corn where the rows were not on the contour. Had this field been protected by alternate close-growing strips and cultivated on the contour the loss to the farmer would have been prevented, and the State would have been saved the expense of removing the soil from the highway.

REDUCTION IN FERTILIZER COSTS

The use of commercial fertilizers is greatest in the southern and eastern part of the United States, where cultivation, with its accompanying erosive effects, has been continued for a longer period than in other parts of the country. The use of fertilizer, however, is

becoming necessary in some of the relatively newer farming sections of the West, where the natural supply of plant foods is becoming diminished.

The heavy costs of replacing plant foods by fertilizer can be greatly decreased by the proper conservation of the natural fertility of the soil and by increasing its organic content. These ends can be at least partly achieved by strip cropping, which retards the flow of surface water, reduces the loss of topsoil and, when combined with good agronomic practices, adds to the amount of organic matter in the soil. The margin of profit on most farms is not large. The conservation of the natural supply of plant-food constituents which is possible under the strip-cropping system, is a factor in widening this margin of profit.

ECONOMIES IN FARM POWER

Plowing, harrowing, seeding, cultivating, and harvesting are not only easier and more conveniently performed on the level than up and down steep slopes, but these operations, as has been shown under various conditions, can be carried on at less expense in contour farming. In many instances operators have saved from 25 to 30 percent in the power cost of production by farming on the contour or level. This saving has been effected by the use of a three-horse rather than a four-horse team or by a smaller, less expensive tractor, which requires less gasoline. This difference in the cost of production may mean the difference between profit and loss.

PHYSICAL SOIL FACTORS AFFECTING EROSION

The occurrence of sheet and gully erosion depends largely on the amount and velocity of run-off water. Sheet erosion, or the formation of small rills and channels which can be obliterated by tillage implements, occurs on slopes that are not protected by satisfactory cover during most rains that cause run-off (fig. 10). The concentration of these tiny, apparently harmless rills from one or more small watersheds finally results in sufficient volume of silt-laden water to cause gullies.

The texture and depth of soil, steepness of slope, length of slope, and vegetative cover determine for the most part the volume and velocity of run-off for a given intensity and duration of rainfall. Deep sandy soils absorb water readily because of their large-sized pore spaces, and ordinarily are not especially subject to sheet erosion. Where a concentration of water comes from above, however, sandy soils are usually subject to severe gully erosion. Most clay soils do not absorb water readily because the pore spaces are small and easily clogged. This allows a large volume of run-off, which may cause serious erosion. However clay soils are, on the average, more resistant to gully erosion than sandy soils. One of the most erodible soil conditions occurs where a fine sandy loam or silt loam surface soil is underlaid by heavy, impervious clay subsoil. The relatively loose surface material becomes disintegrated easily, and the tight subsoil prevents rapid downward movement of water through the

soil, causing a large volume of run-off, and consequently a large amount of erosion.

Normally there is little that can be done to improve the permeability of a stiff, hardpan layer in the subsoil. In soils where such a layer exists, measures for controlling erosion must be carefully planned. The permeability and moisture-holding capacity of the surface soil may be increased somewhat by the addition of organic matter and by careful tillage operations. Fortunately, practices that raise the general level of fertility also tend to give increased growth of crops or other cover, which in turn check the run-off water and aid in binding the soil. Most practices that increase soil fertility therefore help at least somewhat in controlling erosion.

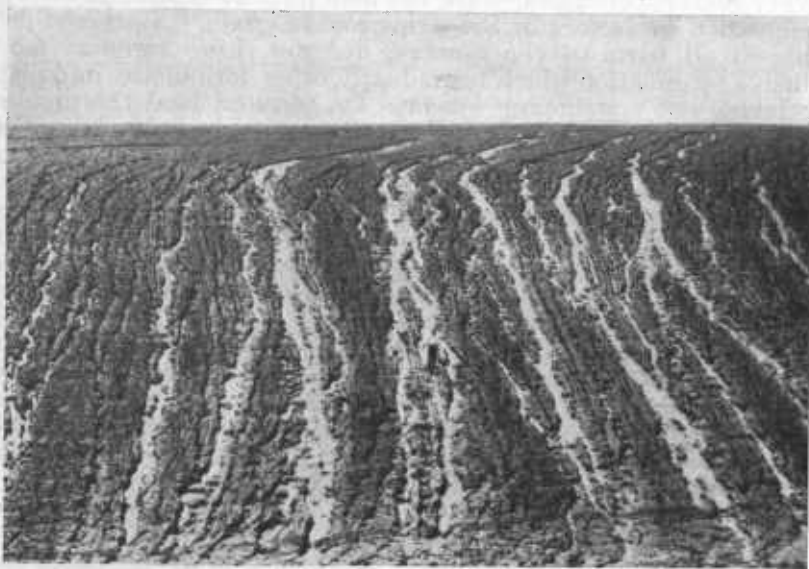


FIGURE 10.—One rain caused this severe sheet erosion of some of the richest wheat soil in the world, the fertile Palouse wheat-belt soil in Washington. This is the result of plowing at one time an entire hillside. Proper strip-cropping methods would have saved this field, which from this one rain lost hundreds of dollars worth of topsoil. Note the size of these gullies as compared with that of the man in the middle foreground.

Steepness of slope, and length of slope affect the rate of flow and the total volume of run-off water. The four general classes of slopes recognized by the Soil Conservation Service are defined on the basis of possible land use, as follows:

A slopes include those nearly level areas where erosion is not a serious problem.

B slopes are those on which cultivated crops of all kinds may be grown safely if proper erosion-control measures are used.

Strip cropping is practically always recommended on B slopes. If other control measures are needed, they should be used in conjunction with strip cropping, rotations, and contour tillage.

C slopes are those on which intertilled crops should not be grown. Close-growing crops are permissible, provided they maintain cover throughout the year. These should be resceded when necessary on a contour-strip basis.

D slopes are those so steep that they should not be cultivated but should be maintained in permanent vegetation.

The actual limits of these groups, expressed in percentage of slope, may vary greatly. Thus, B slopes in one locality may include a range of from 3 to 12 percent, and in another of from 5 to 15 percent, the actual limits depending upon the erodibility of the soil.

The effective length of slope can be regulated or modified to a considerable degree. Strip cropping is one method and the construction of terraces is another. The object of strip cropping is to divide the slope, using strips of grass or close-growing crops which retard the run-off water, causing it to spread out and drop its load of suspended soil.

WIDTH OF STRIPS

Very little experimental work has been done to determine the best combination of factors in the strip-crop program. Numerous field trials in all parts of the country, however, have supplied much valuable information which is gradually being formulated into plans for laying out a strip-crop system. On terraced land the problem is simple, as the terrace interval can be used as a guide regardless of the location of the strips with reference to the terraces. On unterraced land the problem is more complicated. In general the width of the strips will depend on several factors such as type of soil, percentage of slope, length of slope, amount of rainfall, kind of crops, rotation, use of cover crops, amount of soil humus, and general fertility. The width may also be in part determined by the farmer's needs and the type of farming followed.

In those areas where clean-tilled row crops predominate, care should be taken to provide as much close-growing crops as can be economically used. There may be some farms on which it will be necessary to modify the type of farming in order to plan a balanced system. The plan should provide for a permanent system so that an approved rotation of crops can be followed each year without relocating the boundaries of the strips and so that the acreage of crops can be maintained to meet the operator's needs.

An error commonly made in strip cropping is to get the strips containing the erosion-permitting crop too wide and the strips containing the erosion-resistant crop too narrow. This has been done especially in some of the early work to prevent wind erosion where the strips were laid out crosswise of the prevailing winds and where strip cropping was combined with summer fallow.

In Region 1 (fig. 11), this formula for width of strips is being used by some of the projects: $100 \times \text{contour interval divided by percent of slope equals horizontal width of strips}$. For example, if the contour interval is 10 feet and the percent of slope 10, the width of the strips is $\frac{100 \times 10}{10} = 100$ feet. In this formula if the contour interval is constant, as 10 feet, the width of the strips decreases at an accelerated rate for each percent of slope increase.

In Region 3 (fig. 11), the formula $98 - 7(S - 10) = W$ is used, wherein W represents width of strip and S represents slope or percent of slope. With this formula the width of the strips decreases at a uniform rate for each percent of increase in the slope.

In Region 4 (fig. 11), on certain Texas soils, slope length and steepness have been found to be two important determining factors. For example, on A slopes (0 to 3 percent) at least 25 feet of erosion-resistant crops is recommended for each 100 feet of slope length, on B slopes (3 to 5 percent) 35 feet, and on steeper slopes (5 to 8 percent) at least 50 feet. This system may cause some confusion as the strips are rotated over a period of years.

While there is not, and probably never will be, a general rule that can be applied to all parts of the country in determining the optimum width of the strips, there is in almost every soil-conservation region a fairly complete laboratory consisting of the demonstration and camp areas where strip width as well as other factors can be observed and studied. This information will then serve as a valuable guide in each of these regions.

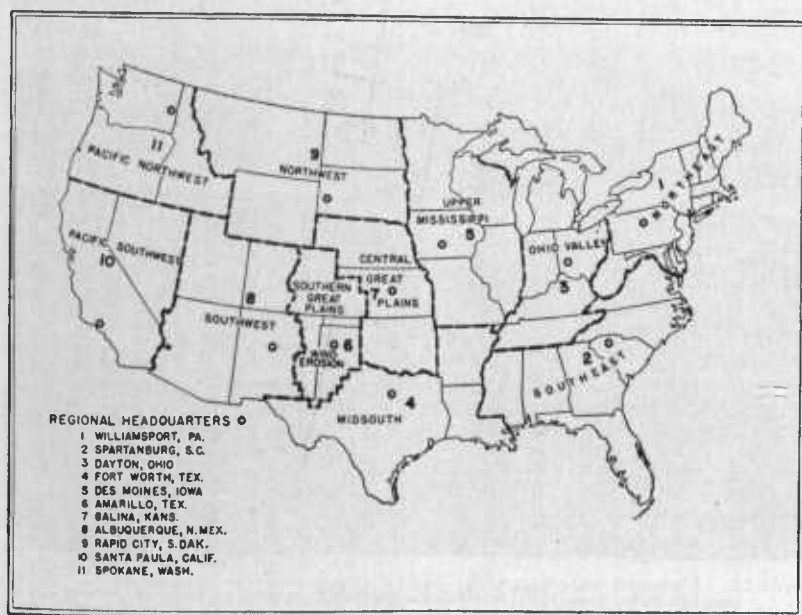


FIGURE 11.—Soil-conservation regions of the United States.

Another means of establishing the width of the strips is to use the same tables and methods that are used by the engineer to determine terrace intervals. This method should be used only as an approximate guide since each strip may not absorb all the water that it receives as precipitation or run-off from higher areas. On long, unterraced slopes, therefore, the strips may need to be somewhat narrower than the interval proposed for terraces.

Whatever method is used to determine the optimum width of strips, good judgment should always be exercised in making slight adjustments so that the width of the strips will fit the farming implements, especially the planters, drills, and harvesters. Eventually farm implements may be obtained to better meet the needs of a strip-crop method of farming.

DEVIATION FROM THE CONTOUR

After the width of the strips has been determined for any given set of conditions and the contour lines governing these strips have been established, irregularities of relief may make it impossible to keep rows parallel to these lines strictly on the contour. This makes it necessary (1) to have point rows, which are difficult to cultivate, or (2) to keep the rows parallel and permit some deviation from the contour. The percentage of deviation which can be used safely without causing accelerated erosion will have to be determined by field observations or by experimental work. Contour strip cropping, however, should not deviate very far from the contour unless provision is made for grassed waterways to conduct the accumulated water through the succeeding strips to the foot of the slope (fig. 12).



FIGURE 12.—A grassed waterway about 40 feet wide, on an 8-percent slope, for conducting surplus water from cultivated fields down long slopes to natural outlets.

Over 1,000,000 acres of strip cropping has been planned at field demonstrations which have recently been established in many parts of the country. This work, if carefully observed, will supply the answer in regard to many matters that are not now well understood.

As a starting point, several of the regions have adopted arbitrary standards for laying out the contour strips. For example, one region allows a deviation from the contour of one-half the amount of the A slopes. If A slopes range from 0 to 3 percent, a $1\frac{1}{2}$ -percent deviation ($1\frac{1}{2}$ -foot rise or fall in 100 feet) would be tolerated. If A slopes range from 0 to 5 percent, than a $2\frac{1}{2}$ -percent deviation would be permitted. The amount of deviation depends on the type of soil and the length of slope. Under some conditions, the relief may have rather abrupt irregularities with short slopes, in which case a greater

deviation from the contour for a short distance would cause no serious erosion.

Any carefully planned system of contour strip cropping must be practical. It is desirable to have parallel strips of fairly uniform width in order to facilitate cultivation, maintain a proper crop balance, and follow an approved crop rotation.

When the character of the land will admit, a modified contour strip system is sometimes used in which the deviation from the contour will be sufficiently great to concentrate the water in the low areas, where it is kept under control, as shown in figures 12 and 14, with vegetated waterways or rather flat grass-lined channels which are maintained permanently.

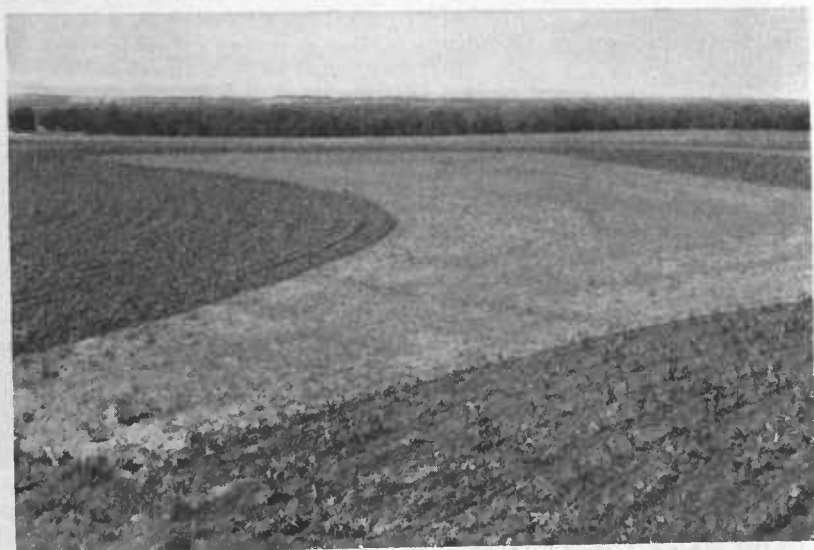


FIGURE 13.—Correction strip. By taking up the irregularities correction strips eliminate the point rows in the cultivated strips. They should be seeded to such close-growing crops as small grain or grass.

CORRECTION STRIP

In laying out a strip-cropping system it is always advisable to keep the cultivated row-crop strip uniform in width to eliminate point rows. Knolls, hummocks, swales, sinkholes, or any odd topographical feature, however, may make it impossible to keep all of the strips uniform in width. "Correction strip" is the term applied to irregular areas of land of uneven width placed between contour plantings of cultivated crops to keep the cultivated strips uniform in width. In laying out a cultivated strip upward from the base line, rows are laid out parallel to the base line until at some point they reach the maximum allowable deviation from the true contour. It is then necessary to go farther up the slope to the next established base line and lay strips off parallel on the downward side until the maximum deviation from the true contour is reached. This irregular strip (fig. 13) between the two row-crop strips is the correction strip.

These strips are seeded to some close-growing crop which is resistant to the erosive action of water or wind and can be grown in odd-shaped fields without disadvantage in cultural operations. Greater erosion control is afforded by permanent types of vegetation, such as hay or meadow crops, but small grains, annual hay, or grass may be sown either before or after the row crops are planted. The cultivated strips should be measured off first, the width depending on the total width allowable and the number of cultivated rows desirable within the strip; then the areas in between seeded to the erosion-resisting crop. In the average farm lay-out there will not be an excessive acreage of land devoted to correction strips, so they are often planted to a good legume hay crop. When it becomes necessary to reseed these irregular areas, they are not customarily used for cultivated row crops but are kept in small grains such as wheat, oats, or barley, which may be employed as a nurse crop for the hay seeding.

GRASSED WATERWAYS

In almost every cultivated field there are natural depressions, swales, or draws down which water naturally tends to flow. When seeded to grass, these waterways aid in the removal of surplus water from a field. They may be used to conduct water from terrace outlets and diversion terraces, diversion ditches, or any mechanical structure or strip-crop rows. Grassed waterways may be entirely natural depressions or may be constructed artificially. In laying out a field for strip cropping, rows that cannot be placed on the exact contour should lead into a grassed waterway so that any excess water collected in the rows may be emptied into the waterway and conducted safely from the field.

Several factors must be considered in planning grassed waterways that will function both as water conductors and productive hay land or meadow. The size of the waterway will depend on a number of factors such as size of drainage area, steepness of relief, type of soil, width of strips, how nearly the strips follow the true contour, and rotation of crops. One of the common mistakes in laying out waterways in a strip-cropped field is to make the grassed area too small. This not only is likely to allow the water to cut a new channel down either side of the grass, but also makes maintenance difficult. If the grassed area is made large enough, the herbage might be cut for hay (fig. 14); or the plot might be used as a means of getting from one strip to another or as a good emergency pasture in favorable locations if a temporary fence is put up around it. When grassed areas are of sufficient size to allow maintaining them as hayfields, there is no loss in productivity, and they are more likely to be kept in a better functioning condition.

Any close-growing type of vegetation can be used, such as bluegrass, alfalfa with timothy, orchard grass, or brome grass in a mixture in the North; lespedeza, Bermuda grass, or carpet grass in the South. Alfalfa alone does not give as good protection against erosion as when used in combination with some grass or sod-forming

plants. The advantage of alfalfa and timothy, or lespedeza in the South, is that a very valuable hay crop is obtained from land which might otherwise be out of production. A Kentucky bluegrass or white Dutch clover sod is perhaps the most ideal type of vegetation for waterways when a temporary or emergency pasture is needed. The grass blades lie over under the pressure of running water, lapping the ground like shingles on the roof of a house. To insure this dense covering of protective grass shingles, it is important that attention be given to proper fertilization and cultural practices. Care



FIGURE 14.—A well-managed waterway in Iowa. Notice the haystack in the background, a byproduct of this waterway construction to provide insurance against gully-forming erosion. Where possible, waterways should be sufficiently wide to be maintained with the regular farm equipment at no extra cost.

should be exercised in the tillage operations to lift the plows, harrows, cultivators, and diggers so as not to disturb or ruin the permanent grassed area down the waterway.

BUFFER OR SPREADER STRIPS

The term "buffer strip", in soil-conservation work, refers to a more or less permanent contour strip, usually of variable width, planted to a sod or other erosion-resisting form of vegetation, which is not a part of the regular farm rotation and therefore may or may not be harvested. The width of these buffer strips is usually between 8 and 20 feet, depending on the type of vegetation used, relief, soil type, rainfall, and type of farming practiced. A series of these buffer strips may be used on a long cultivated slope to break up the erosive force of the water by spreading it out and causing it to deposit its load of silt. By continual cultivation and plowing, eventually a berm will be thrown up along the upper side of this permanent buffer strip and will act very much like a miniature terrace.

Buffer strips should not be confused with a good rotation strip-cropping system. The area in erosion-resisting crops under a buffer system is smaller than under a regular strip-crop system, and the control of soil and water wastage is usually correspondingly less (fig. 15). Buffer strips may become areas of idle land for the accumulation of rocks hauled from the adjoining cultivated strip, or areas of brush and weeds. In some sections where the land is benchlike in topography the level areas between the steps are cultivated, but the steep areas between the benches are not broken and therefore may be classed as a permanent form of buffer strip.

Buffer strips are used most often in trucking sections and in orchards where clean cultivation is practiced. On truck farms, where erosion-resisting crops have no sale value and livestock are not used



FIGURE 15.—Narrow, widely spaced buffer strips should not be expected to control erosion on 40-percent slopes of cultivated lands. Long, excessively steep slopes of this character should be protected by permanent vegetation.

at all, or very little, every available foot of land is planted, not only once but often two or three times a year, to a truck crop sold for cash. Farmers who seek to preserve the fertility of their soil often sow their entire acreage to a winter cover crop to be plowed down just as early in the spring as possible. Here a buffer strip of 8 to 20 feet in width will not take too great an area out of cash crops and will aid greatly in erosion control. Buffer strips also help the truck farmer to plant and cultivate on the contour, a practice which is a material aid in controlling the run-off.

Buffer strips are often used in orchards either in the tree row or in the alternate spaces between rows. If the tree row itself is left in sod and one-way cultivation practiced, in time a system of bench-

like terraces is built up, and level cultivation results (fig. 16). Permanent buffers have been used in connection with cover crops in every other or every third interval between rows in peach orchards. Clean cultivation is advocated during certain critical periods of the year in peach orchards to eliminate competition of the grass with the trees for moisture, but where only a narrow buffer strip is left this competition, especially if the grass is mowed, does not interfere so greatly with either the quantity or quality of the fruit set. The great value in saving the expensive orchard land, thus allowing continued production for many years, may far offset any loss in quantity or quality for any one year. A buffer system has little practical value in rotated cultivated fields, but where erosion-resisting crops do not form part of the rotation in sufficient quantity to allow strip cropping, the next-best vegetative-control system must be adopted.



FIGURE 16.—Contour planting, together with buffer strips, is a very effective method of controlling erosion in orchards. Strips of cultivated areas in the intervals between rows separated by erosion-resisting vegetation in the tree rows gives very efficient strip-cropping arrangement in orchards. All cultivation is on the contour or one way. This naturally forms benchlike terraces between the tree rows.

TURN STRIPS

In some fields pointed, narrow ridges or slopes are found around which the strips may run. At the apex of this area, it will aid greatly to keep the rows in the strip an equal distance apart if a small section across the strip is left in sod the year it is in a cultivated crop (figs. 17 and 18). This small area may be used for a roadway across the strip or for turning in order to go back up the same side of the strip just finished. Here again it will be of great benefit to have this area large enough (15 to 30 feet) to mow for hay the year it lies in a cultivated strip. The year the cultivated strip is seeded to small grains or hay this turning area can be plowed in conjunction with the rest of the strip so that no inconvenience will be experienced and no ground lost from production.

BORDER STRIPS

It is usually impossible to plow headlands on the contour with the rest of the field. Roadways from one strip to another are ordinarily needed, and headland or border strips are excellent for that purpose, as well as for terrace or diversion-ditch outlets, or for grassed waterways. If used for grassed waterways they should not be cultivated.

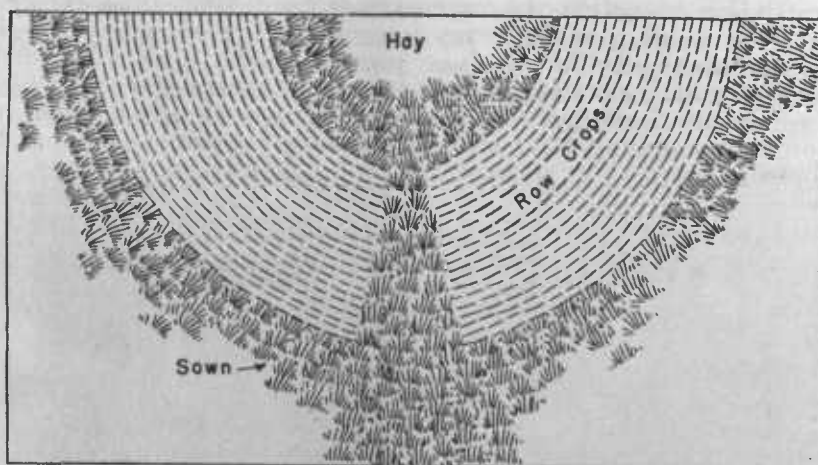


FIGURE 17.—Grass turn strip to facilitate carrying a cultivated strip around a steep, narrow ridge.



FIGURE 18.—On this Minnesota farm contour strip cropping is used to control erosion. The grass turn strip at the end of the corn row, in the left foreground, facilitates tillage operations.

METHOD OF LAYING OUT STRIPS

It is practically impossible to state rules that will apply to all conditions in the actual laying out of a strip-cropping system. A few fundamental suggestions, however, are applicable to any condition. In the first place, one must have the courage to rearrange his farm completely if need be. This may mean relocating fences (fig. 19), taking some steeper lands out of cultivation and retiring



FIGURE 19.—Rearrangement of a farm in Pennsylvania to facilitate strip cropping. An old fence was removed so the field in the background could be united with the one in the foreground, allowing long rows to be run across the entire width of the two former fields. The two waterways in the lower right foreground are well protected by sod in the cultivated row-crop strip.

them to pasture or trees, taking some level pasture lands which are suitable for cultivation out of pasture, planning shorter rotations on the land least subject to erosion, and lengthening the rotation on the more steep, easily eroded lands. It is often advisable to have some well-trained, impersonal agent rearrange the farm because he can see, better than the owner himself, where improvements can be made. Practical, sound soil conservation must be the first consideration, and it may therefore be necessary on some farms to change the farming system or land use to fit these soil-conserving methods.

In laying out a strip-cropping system one should first determine the approximate location of the strips. This requires a careful consideration of existing conditions, such as variations in relief, points where run-off concentrates, drainage area above the field in question, length of the slope, present condition of the soil, soil type, crops used in the rotation, and the type of machinery used in the production of these crops. If possible it is very beneficial to have a soils

map made by some competent person showing the soil type, the degree and kind of erosion, the percentage of slope, the drainageways, and the land cover at the time of making the map. This information should be very conscientiously studied before any attempt is made to establish a base line or starting point for the first strip to be laid out.

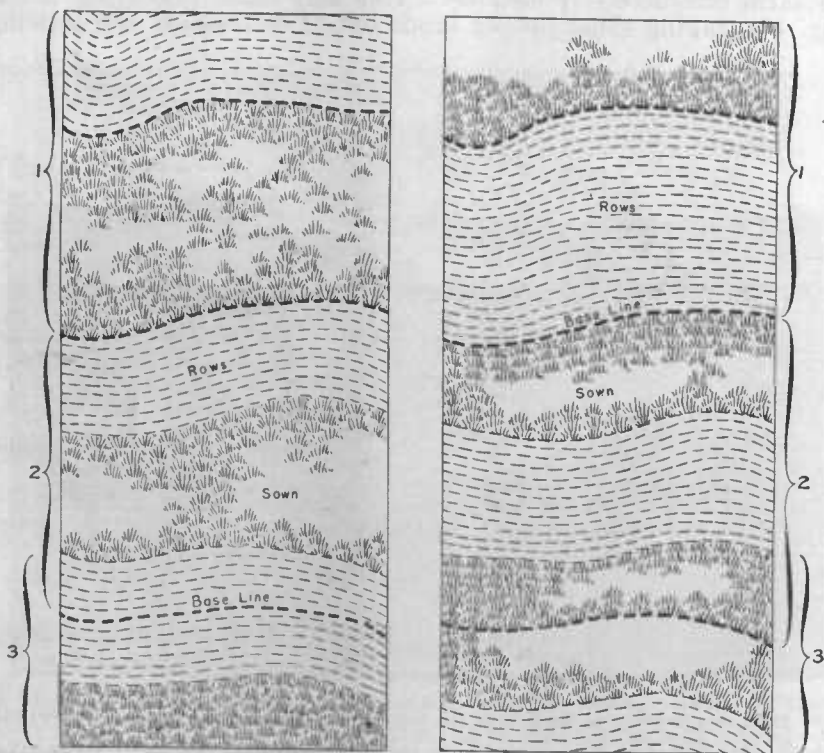


FIGURE 20.—Three methods of locating the base line in laying out crop strips. The strips may be measured either above, below, or straddle the base line.

The line which is to be used for the base of measurements should be laid out on the contour in such a position that as many strips as possible may be measured from it both up and down the slope. This base line may be laid out by various methods but it must be exactly on the true contour; otherwise the very purpose of contour-strip farming is defeated. There are three ways of locating the base line (fig. 20). It may form either the bottom or the top boundary of the strip or it may be used for the center line. Efforts should be made to have boundaries that are located by measurement from this contour base placed on ground which has a gradual slope. This will allow greater variation from the contour line up or down the slope without exceeding the variation in the grade limit allowable under those particular conditions. If the relief is very uneven,

one base line may serve for only two or three strips, and then a new base line must be established farther up the slope. This will often necessitate the use of a correction strip between the last two regular even-width cropping strips.

The boundaries of the strip may be measured from the base line with a tape measure carried by two men, one walking directly on the base line and the other at the desired distance from the base at the other end of the tight tapeline, which must be kept at right angles to the base line. Stakes can be set 50 or 100 feet apart by the man who is staking the strip boundary. Care must be taken to insure that he keep the tape at right angles to the base line. Otherwise, the strip will not be of uniform width.

Any comparatively accurate method may be used in locating cropping-strip boundaries, or the base line, but the eye alone is not a satisfactory instrument. For ordinary slopes, an Abney level, Locke level, line level, or any common level will be satisfactory. On long, relatively uniform contours, a tripod level is advantageous as less time will be required to locate the boundaries because of the extended range of vision which the telescope makes possible. If, upon checking the strip boundaries after they are laid out, it is found that at one or more places the deviation from the true contour is greater than the allowable limits, it may be possible to move the base line slightly up or down the hill to take up this difference and still keep all points of every strip measured from this base within the allowable deviations from the true contour. After the strip boundaries have been determined and staked, they should be plowed in with a single furrow immediately, if possible, to prevent livestock from knocking over the stakes or their being moved in some other manner which would erase the exact location of the strip boundary. Obviously, strips should be laid out at a time of year when the least damage will be done to the crops and when the work will fit in well with the rotation and cropping plans. It may not be possible to bring an entire farm under a strip-cropping plan the first season, on account of disrupting the rotation (fig. 21), but usually 3 years is sufficient time in which to bring every cultivated field into the strip-cropping plan.

LAYING OUT STRIPS ON TERRACED LAND

Laying out a strip-crop system on terraced land is relatively simple because the contours are permanently marked by the terraces and the width of strips can be adjusted to the terrace interval. There are several methods of locating the strips on terraced fields. They can be placed on the terrace interval, from terrace to terrace (figs. 22 and 23), or they can be placed to straddle the terraces (fig. 24), with approximately 50 percent of a given strip above and 50 percent below the ridge. These two general plans are sometimes modified to meet special soil conditions or unusual crop requirements. For example, to reinforce the earth structure, close-growing erosion-resistant crops may be seeded on either side of or on the terrace ridge (fig. 25), extending only a short distance above and below the ridge, or such crops may be seeded on the irregular correction strip in the middle of the terrace interval to take up space otherwise occupied by



FIGURE 21.—In starting his strip-crop operations an Ohio farmer prepared and seeded the oat strips in early April, leaving the adjacent sod strips for protection until the oats were established. The corn strips were then prepared and planted about the middle of May, when the oat strips afforded protection against erosion. After the system is established, it is more effective if adjacent spring-seeded strips can be avoided. Wheat, rye, or winter barley could have been substituted for oats for the control strip.



FIGURE 22.—Strips laid out on the terrace interval with the terraces forming the boundary. Winter oats form the close-growing crop between alternate strips of cotton in Oklahoma.

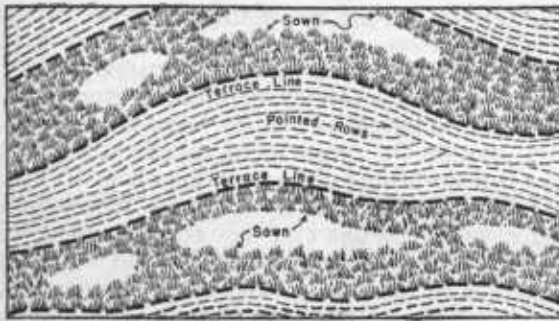


FIGURE 23.—Strips laid out on the terrace intervals with terrace ridges forming the boundaries of the strips.

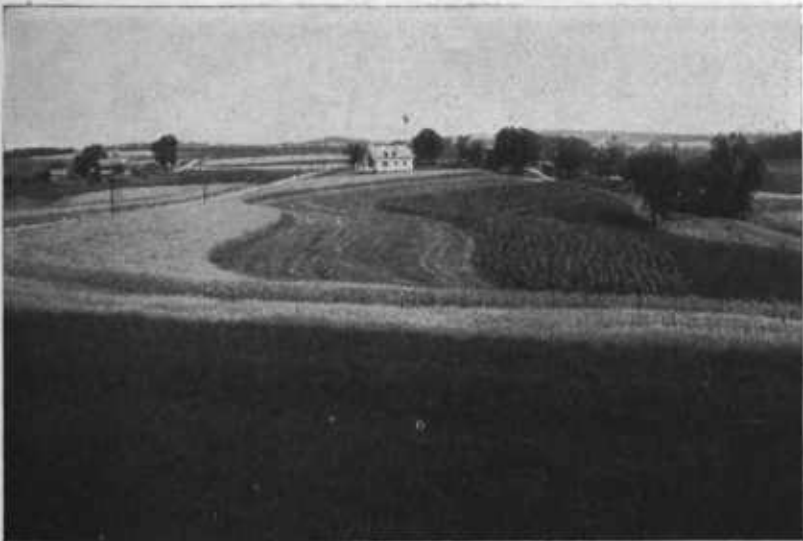


FIGURE 24.—Placing strips straddle the terrace ridge permits uniform-width row-crop strips and avoids point rows because the irregular areas are taken up by the close-growing crops. The advantages of this system are that it permits a complete rotation of crops, reduces slope length, and reinforces the terrace system.

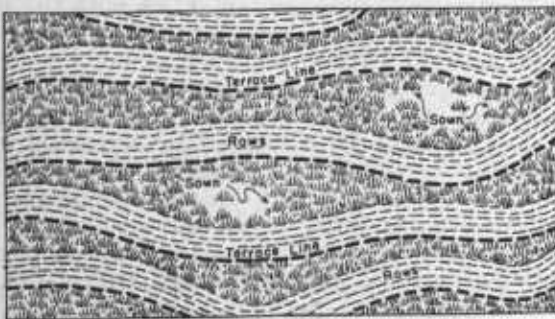


FIGURE 25.—Strips laid out on either side of the terrace ridge, occupying only part of the terrace interval.

point rows. The rest of the space may be used for production of row crops, such as cotton or corn. These modified strips rarely can be permanently employed to advantage because of the difficulty of maintaining a proper crop balance or a satisfactory rotation.

Usually the best arrangement is to have the strips straddle the terrace. This permits the crops to be satisfactorily rotated, with a division of the row crops and close-growing crops to suit the needs of the operator. The ideal system is to have a row-crop strip with as many parallel rows as possible on every other terrace, with the intervening terraces and irregular strips devoted to erosion-resistant crops, as illustrated in figure 26. This does away with objectionable point rows and has the advantage of providing for an amount of close-growing crops at least equal to the row crops.



FIGURE 26.—Strips laid out to straddle the terrace ridges. This is a very practical method and is easy to follow with a rotation of crops.

On practically all land that requires terracing, strip cropping should be practiced in order to protect the mechanical structures, rebuild the soil, and permit the operator to follow a constructive type of farming rather than a destructive single-crop type.

LAYING OUT STRIPS ON LAND TO BE TERRACED

The construction of a complete terracing system, including outlets, requires some time and a considerable cash outlay. It will have to be done when soil and weather conditions will permit work in the fields. This limitation of time may interfere with the production of the regular farm crops or cause damage to growing crops unless they are planned to facilitate terrace construction.

In laying out strips on land to be terraced, the operator can arrange his crops so that a strip of early-maturing vegetation will occupy the actual area to be disturbed by the construction of the terrace. This will necessitate a complete survey of the land to be terraced and the establishing of all terrace lines before seeding. As soon as the crops are harvested on the terrace contour, construction can be started without damage to the areas between terraces. After the terracing is completed, this temporary system can be replaced and the permanent one laid according to the suggested plans discussed in the preceding section.

FIELD STRIP CROPPING

Field strip cropping is a modified form of contour strip cropping. Areas laid out for field strip cropping are simply divided into parallel strips across the general slope (fig. 27) and may or may not be on the contour.



FIGURE 27.—A Wisconsin farmer takes the first step in controlling erosion on his farm by field strip cropping. Note the alternate strips of corn and hay with the low areas protected by grassed waterways. Using this system is much better than having the entire field in corn at one time but does not control erosion as effectively as it would if the strips were on the true contour.

This is not a good system under some conditions and may result in more harm than good if not carefully watched, as water may have a tendency to accumulate in low areas where no accumulation occurred when the rows were run up and down the slopes. Natural or seeded grassed waterways carefully maintained wherever rows tend to collect water will do much to carry away any surplus water accumulated by field strips, and under careful management no trouble will result.

WIND STRIP CROPPING

Wind strip cropping, as previously defined, is the production of the regular farm crops in long, relatively narrow, parallel strips, placed crosswise of the direction of the prevailing wind without regard to the contour of the land. This system is employed in both the High Plains and the northern Great Plains, which are subject to severe wind erosion (fig. 28) and usually have scanty rainfall. Its application, therefore, is somewhat limited. It is sometimes modified by using vegetation or crops that are not a part of the rotation or that may not be harvested. Sometimes Sudan grass or some of the grain sorghums are planted in very wide rows on land which later will be seeded solid to grass or small grain. This gives protection

from the wind until the regular crop becomes established. In some areas of scant rainfall, where summer fallow is practiced, strips of stubble, sweetclover, Sudan grass, or stooling varieties of sorghum can be used in alternate strips to break the force of the wind, hold snow, and otherwise protect the small grains during critical windy periods.



FIGURE 28.—Wind erosion takes its toll. The wind has not only removed the valuable topsoil from the fields but has buried farm property under drifts.

In localities where wind erosion has gained sufficient headway to start sand dunes, and where it is very difficult to establish any type of vegetation because of the movement of the sand, it is questionable whether the production of cultivated crops should ever be attempted. The effort is almost sure to result in failure. The failure to establish vegetation will result in soil blowing, and the moving sand will destroy other land that might be used for crop production. These areas should not be used for crop production but should be retired to grass or any type of permanent vegetation that can be established, after which the land should never be plowed.

In most of the areas subject to wind erosion rainfall is light, and moisture conservation is of primary importance. Much of the limited rainfall occurs as cloudbursts in localized areas and usually results in heavy run-off and severe soil losses. Rainfall records indicate that the total annual precipitation is relatively small. If all of it were retained in the soil for crop production it would be insufficient for maximum yields. Since the need for water conservation is urgent, farmers and agronomists favor contour strip cropping, which will save all the moisture and possibly be just as effective in controlling wind erosion. The increased growth of vegetation resulting from this extra water would be an additional factor in preventing soil blowing.

Expensive methods cannot be justified in any program for the control of wind or water erosion and the conservation of moisture in the semiarid area of the Great Plains, where much of the land is low in price. Strip cropping, preferably on the contour, meets this necessity for economical methods. It can be adapted and maintained by farm operators at practically no cost and may in some instances result in a direct saving in the cost of power and equipment.

CROPS PERMITTING EROSION

Certain crops resist the erosive action of the elements more than others. Those which least retard erosion are such clean-cultivated crops as corn, cotton, potatoes, tobacco, sugar beets, and truck crops. Clean-tilled orchards are also subject to erosion.

There are a number of reasons why these crops are conducive to erosion. The land on which they are grown is bare and open to beating rains a good part of the year before the plants are high enough to afford much protection to the soil. The raindrops have direct access to the ground between the rows and so strike the soil with considerable force. Forms of vegetation that break the striking force of the raindrops cause them to scatter and drop gently to the ground. The denser the vegetative covering the more gently will the falling water reach the ground surface. This foliage cover is also of benefit in shading the ground against the sun's rays, which have a tendency to bake the soil after a rain and lessen the absorption of the following rains.

Cultivated row crops do not entangle the surface layer of the soil with as dense a root growth as do sod crops and their resistance to erosion is correspondingly less.

COVER CROPS

Winter cover crops should be used whenever possible on all row-crop strips to shorten the period during which these strips are subject to maximum erosion. Some cover crops, such as rye, winter oats or barley, wheat, and several of the legumes, can be seeded when the row crop is last cultivated, if this is not done too early. In some areas in the South, seeding of the legumes should be delayed until the danger of root infections is past. A well-established cover (fig. 29) will give protection to the soil against beating rains during the fall and winter, will open the soil for greater absorption, increase the humus and the organic content, prevent leaching of nitrogen, and may greatly increase the productivity of the soil. Winter cover crops on the clean-tilled strips, together with the protection afforded by the regular close-growing crops, will reduce soil movement to a minimum.

COMBINING PROTECTIVE AND SOIL-BUILDING CROPS

Crops that resist erosion are frequently soil-buildings crops. All of the legumes, when properly inoculated and grown on neutral or sweet soil, provided they produce a good top growth to turn under, may be classed as soil-improving or soil-building crops, but they may not all be classed as erosion-resistant crops. While the non-

legumes such as Kentucky bluegrass, Canada bluegrass, redtop, carpet grass, Dallis grass, blue grama, and the whole group of turf-forming grasses gather no nitrogen from the air, they are nevertheless important in soil building and are the most erosion-resistant plants available to the farmer.

Legumes such as alfalfa, sweetclover, red clover, alsike, crimson clover, vetch, Austrian winter peas, and many others can be used successfully in contour strip-crop rotation with erosion-inducing crops, such as corn and cotton, and provide an effective soil-building and erosion-resistant cropping system. It has been found that a mixture of legumes and grasses, such as alfalfa and timothy, alfalfa and smooth brome grass, red clover and timothy, alsike and timothy,



FIGURE 29.—Rye seeded at the last cultivation of corn shortens the period when corn ground is most subject to erosion. All clean-tilled strips not followed in the rotation by a fall-sown, close-growing crop should be protected by a winter cover crop.

vetch and rye, and many other mixtures of this type are much more resistant to erosion than the same crops grown in pure stands. It is also a fortunate coincidence that these mixtures will produce more pounds of feed of equally good quality than the individual crops grown in pure stands. All strip-cropping rotations should include some of the soil-building crops.

Care should be taken not to include all the legumes in the erosion-resistant list. Soybeans and cowpeas are excellent soil builders when turned under as green manure, but the mellowing and loosening effect they have on the soil renders them almost worthless to prevent erosion. They should be used, therefore, as soil builders on level land that is not subject to erosion. If they are grown on rolling land in a strip-crop rotation, they should be protected by erosion-resistant strips such as are used for cotton, corn, or other clean-tilled row crops.

In the less humid sections, such as the Great Plains, where the variety of adaptable crops is limited, Sudan grass, the stooling

varieties of grain sorghums, millet, and winter grain crops will have to be substituted for some of the more desirable legume-grass mixtures in the erosion-control strips. Sweetclover is also a desirable crop in this region and is gaining in popularity.

Practically all of the winter grains, such as common and Abruzzi rye, winter oats, wheat, winter barley, and mixtures of rye and vetch, or Italian ryegrass and crimson clover, are resistant to erosion as soon as they establish a ground cover, and can be used effectively on the control strips.

ROTATIONS

Strip cropping can be most effective in conserving soil when the rotation contains a variety of crops differing in their resistance to erosion. Its practical application is much more difficult and less

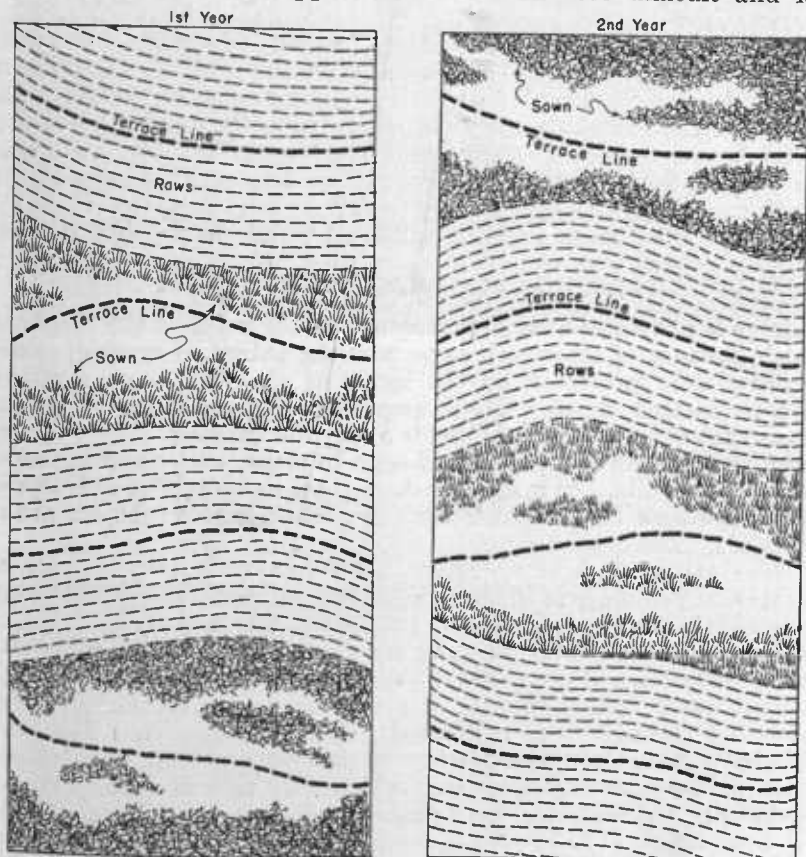


FIGURE 30.—This diagram illustrates how crops can be rotated in a strip-crop system.

effective in areas where a limited number of crops are produced or under a strictly cash-crop system. The greatest objections to strip cropping are found in the one or single-crop sections of the country. A rotation that permits the cultivated crops to follow the sod or hay crops and the small grains to follow the cultivated crops has proved ideal for the control of erosion on cultivated lands. Soil fertility and organic content are very materially increased by plowing under a

good sod or legume before planting the land to a cultivated crop. Plowing under a legume crop every few years greatly improves the physical condition or tilth and considerably increases the absorption of moisture.

The maintenance of a good rotation is one of the main steps in setting up a strip-cropping system, and the crop sequence within or between the strips themselves is especially important. No two cultivated crop strips should be adjacent, and no two strips having the same planting or harvesting dates. If possible, a cultivated row-crop strip should be bounded on either side by a hay strip (fig. 30), but since this practice would produce a surplus of hay, small grains are very often planted instead. On many farms it is possible to use forage crops, and in such instances a strip of grass on either side of the small grain will eliminate back swathing the small grain at harvest time.

It is the practice in certain sections to plant wheat on corn stubble before the corn shocks can be removed from the field. If a grass strip is placed between strips of corn the shocks can be carried over and set up on the grass, allowing the entire corn strip to be planted to wheat at one time. Arranging similar types of crops in groups on the various fields of the farm greatly facilitates the planting, cultivating, and harvesting. If it is positively necessary to pasture the aftermath, this can be done on all fields which do not include corn.

PERENNIAL STRIPS IN THE SOUTHEAST

There are areas in a large percentage of the fields of the Southeast which, because of slope, soil type, and the extent of erosion, cannot be adequately protected by the kinds of close-growing vegetation used in rotated strips. These areas are frequently fairly regular bands that extend across the fields along the contour. They usually occur where there is an abrupt change in slope, with resulting acceleration of erosion. In many instances these areas represent land that should not have been cleared, but cannot be reforested because of its location in cultivated fields.

Observations made in numerous fields following heavy rains have shown that erosion was much more severe on these areas than on the more gently sloping portions of the fields. Terrace maintenance on such areas is more expensive and crop yields are much smaller than on the remainder of the field. These areas are usually kept in cultivation because farmers do not wish to have strips of abandoned land extending through their cultivated fields. On numerous fields tenants have recognized the futility of cultivating these unprofitable areas and have abandoned them so that they now occur as strips of broomsedge and second-growth pine extending across cultivated fields.

A plan has been developed in the Soil Conservation Service project and camp areas of the Southeast for protecting these vulnerable portions of cultivated fields by planting them to mixtures of perennial grasses, clovers, and annual lespedeza or to deep-rooted perennial legumes such as alfalfa, *Lespedeza sericea*, and kudzu. These strips are never less than one and are often two or more terrace intervals in width.

This type of strip cropping was started in the spring of 1937 as a means of providing protection for areas where the break in slope was so pronounced that these areas were designated "critical slopes."

Since then, however, this type of strip cropping has been expanded so that it is now used as a means of protecting all areas in cultivated fields where, because of slope, soil type, and the extent of erosion, close-growing annuals will not give adequate protection against erosion.

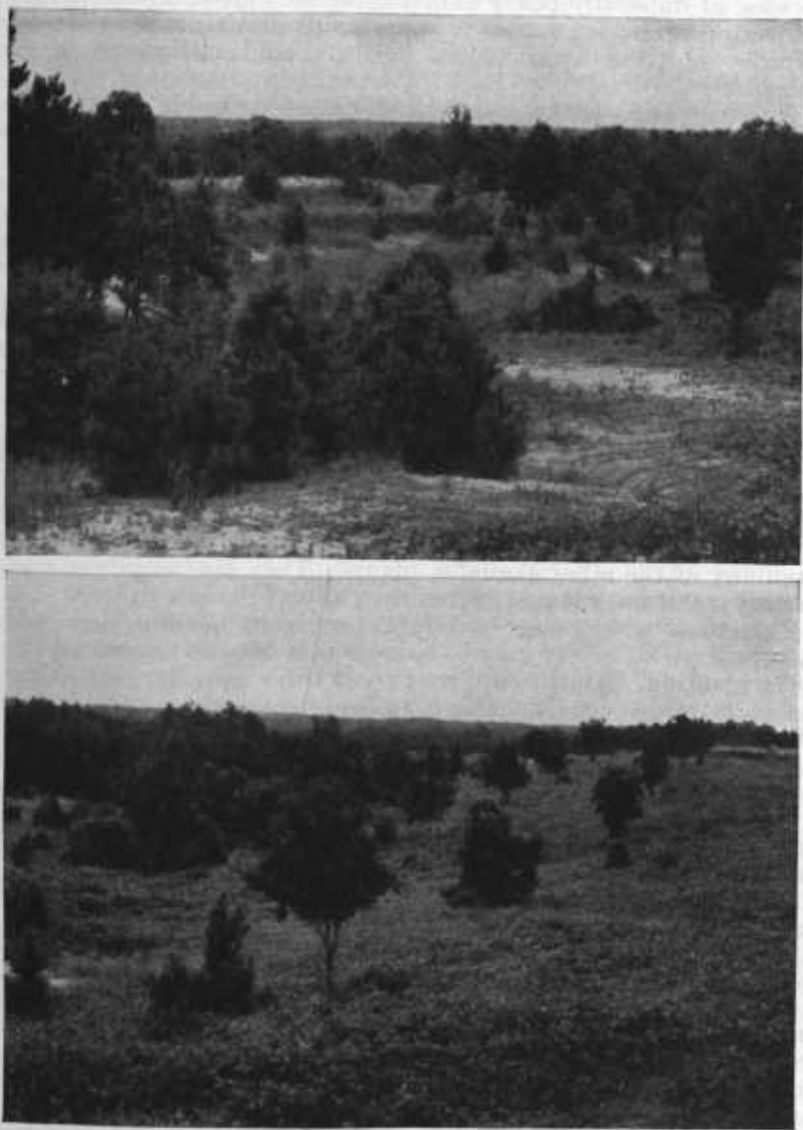


FIGURE 31.—The upper picture shows a formerly cultivated, terraced slope which has not been planted to kudzu. The lower picture shows how kudzu has completely covered an adjoining slope. Thousands of acres of badly eroded areas in cultivated fields have been planted to kudzu in strips on the contour.

The strips of perennials established for the protection of the more vulnerable portions of a cultivated field serve as a permanent foundation for a vegetative program of erosion control. The deep-rooted

perennial vegetation in these strips gives continuous, effective protection to the areas covered and also serves as a secondary line of defense during periods of heavy rainfall. The vegetation in these strips is particularly effective in spreading concentrated water and thus materially reduces the damage to land farther down the slope when, because of unusually heavy rainfall, terraces above the strips break or overtop. The vegetation in these strips also eliminates breaks in terraces on these areas where breaks would ordinarily be most numerous.

In some places where insufficient land of desirable slope is available for crop production long, steep slopes are being strip-cropped with perennials. Approximately 50 percent of the field area is planted to perennials, and the intervals between these strips of perennials are used for the production of annual crops. The maximum feasible amount of close-growing vegetation is included in the cropping system. The strips of perennials may be rotated with the annuals once every 4 or 5 years, with the expectation that the organic matter in the soil will be materially benefited and the physical condition much improved to resist erosion. Observations have shown that in this system of treating steep slopes it is necessary to provide for the interception and diversion of the water immediately below each perennial strip.

Lespedeza sericea and kudzu are the plants most commonly used in perennial strip cropping. These two crops were planted in strips on approximately 10,000 acres in the Southeast during 1937. They were used because they are better adapted to unfavorable conditions than any of the other available plants. They also maintain a satisfactory stand for a longer period than any of the other plants.

Lespedeza sericea can be established more quickly than kudzu. Excellent yields of hay may be harvested in May of the second season after planting. Kudzu requires two or three growing seasons under fairly favorable conditions to completely cover the ground and give effective erosion control. Because of its spreading habit of growth, a poor stand of kudzu will eventually give complete cover (fig. 31), whereas *L. sericea* requires a thick initial stand. Kudzu produces a desirable quality of hay if cut at any time between late spring and frost in the fall, whereas the quality of *L. sericea* hay deteriorates rapidly after it is ready to cut.

Kudzu is particularly valuable for establishing strips where the supply of plants is limited. One row planted through the center of a strip 50 to 100 feet wide will cover the entire strip within a few years, provided proper soil preparation, fertilization, and cultivation are given. Strips have been established in a few instances by planting kudzu on terrace ridges and growing cultivated row crops in the intervals between terraces until the kudzu vines had spread over the intervals between terraces. Kudzu can easily be confined to the strip areas by cultivation.

This type of perennial strip cropping is not a complete vegetative program. It is a means of protecting the most vulnerable portions of cultivated fields, and it also provides an excellent foundation for a vegetative program on the rest of the field.

OTHER PUBLICATIONS ON FARMING PRACTICES THAT CONSERVE SOIL

Strip cropping is one of the several related practices that maintain the productivity of farm land. Several publications are now available on these methods of farming that conserve soil. These bulletins and leaflets, which can be obtained from the United States Department of Agriculture, are listed in two groups. Those in the first group deal with particular conservation practices, and those in the second group describe how these practices have been applied in a particular region.

Cover Crops for Soil Conservation. Farmers' Bulletin No. 1758.
Legumes in Soil Conservation Practices. Leaflet No. 163.
Soil-Depleting, Soil-Conserving, and Soil-Building Crops. Leaflet No. 165.
Terracing for Soil and Water Conservation. Farmers' Bulletin No. 1789.
Soil Productivity as Affected by Crop Rotation. Farmers' Bulletin No. 1475.
Erosion on Roads and Adjacent Lands. Leaflet No. 164.

Soil Defense in the Piedmont. Farmers' Bulletin No. 1767.
Soil Defense in the South. Farmers' Bulletin No. 1809.
Soil Defense in the Northeast. Farmers' Bulletin No. 1810.
Soil and Water Conservation in the Pacific Northwest. Farmers' Bulletin No. 1773.
Conserving Corn Belt Soil. Farmers' Bulletin No. 1795.

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